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TEST TO IMPROVE FUEL CONSUMPTION CHARACTERISTICS OF THE STROMBERG TYPE NA-D6 CARBURETOR ON THE 300 H. P. HISPANO-SUIZA ENGINE

(POWER PLANT SECTION REPORT)

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TEST TO IMPROVE FUEL CONSUMPTION CHARACTERISTICS OF THE STROMBERG TYPE NA-D6 CARBURETOR ON THE 300 H. P. HISPANO-SUIZA ENGINE.

OBJECT OF TEST.

The object of this test was to improve the fuel consumption characteristics of the type NA-D6 Stromberg carburetor on the 300-horsepower Hispano-Suiza engine, especially at part throttle positions.

SUMMARY OF RESULTS.

A new type of accelerating well was devised which, with a slight change in the carburetor, reduces the fuel consumption materially, at the same time retaining all accelerating qualities.

CONCLUSIONS.

It is recommended that this modified type of well and setting be adopted as standard for all NA-D6 carburetors.

INTRODUCTION AND DESCRIPTION.

As will be noted from the fuel consumption curve in Figure 2, the fuel consumption of the Hispano-Suiza 300-horsepower engine with the NA-D6 type of carburetor is excessive, especially at part throttle, with the mixture control in the full rich position.

The high specific fuel consumption at full throttle is caused by the large size of fuel metering orifice necessary for satisfactory acceleration of the engine. The rapid rise of the specific fuel consumption curve as the engine is throttled on propeller load is a characteristic of the double venturi construction. This inherent enrichment of the mixture by the double venturi is made more pronounced in the NA-D6 carburetor by the use of an air bleed accelerating well.

It is obvious from these curves that if the accelerating qualities could be retained the fuel consumption could be reduced considerably both at full and part throttle without reaching mixtures so lean as to cause bad engine operation.

The Stromberg NA-D6 carburetor (see Figure 4) is of the air bleed, double venturi type, and the principles of operation are the same as all Stromberg carburetors. The fuel reaches the engine by passing from the float chamber through a metering orifice and accelerating well to a discharge nozzle from which it is drawn into the passing air stream. The idling is accomplished by means of separate idling tubes which are connected to the outside of the accelerating wells at the bottom and which pass up the back of the barrels of the carburetor, the fuel entering the main passages at the points where the butterfly throttles touch the walls in closing. The accelerating well (see Figure 5) contains small holes which serve a triple purpose. The primary purpose of these holes is to allow fuel to enter from the outside of the accelerating well when the throttle is opened rapidly, thus giving a richer mixture for acceleration. At full throttle operation these holes act as air bleeds allowing air, which is taken from behind the venturis and passes down the side of the idling tube, to enter the main discharge. These holes also serve to feed the idling well and consequently furnish the fuel for idling speeds. The standard setting for this carburetor is as follows: Large venturi—1$\frac{11}{16}$-inch; size of metering orifice—No. 32 drill size, accelerating well as shown in Figure 5.

METHOD OF TESTING.

This test was made using NA-D6 carburetors applied to Hispano-Suiza 300-horsepower engines mounted on both the dynamometer and torque stand and finally tested in flight. For the method of making runs and taking readings see Engineering Division Report, Serial No. 1507. Full power and propeller load runs on the dynamometer were made with every variation of carburetor setting tried, and the changes giving the most favorable results were tried for acceleration on the torque stand.

In all a total of 108 runs were made throughout the test. The trials for acceleration were made on the torque stand with the engine equipped with a propeller. Throughout the test the fuel consumption was kept within the desired limits by changing the fuel metering orifice size.

The test can be divided into three phases. At first it was decided to try to obtain a decrease in the fuel consumption without altering the main carburetor body but only the accelerating well and this by changing the location, size, or number of the air-bleed holes. In this way it was hoped to flatten the specific fuel consumption curve on propeller load. The air-bleed holes were systematically shifted from the bottom to the top of the accelerating well by stages and runs made for each location and size. Also the idle was both eliminated and fed directly from the float chamber. The results of these tests showed that the smaller the number of air-bleed holes, and the closer these holes were to the top of the well, the flatter the propeller load specific fuel consumption curve obtained and the better the fuel consumptions at throttled loads. From these results an accelerating well was made which materially reduced the specific fuel consumption on propeller load. However, when tried out on the torque stand the engine acceleration with this well in the carburetor was not good and the well could not, therefore, be recommended for service use.

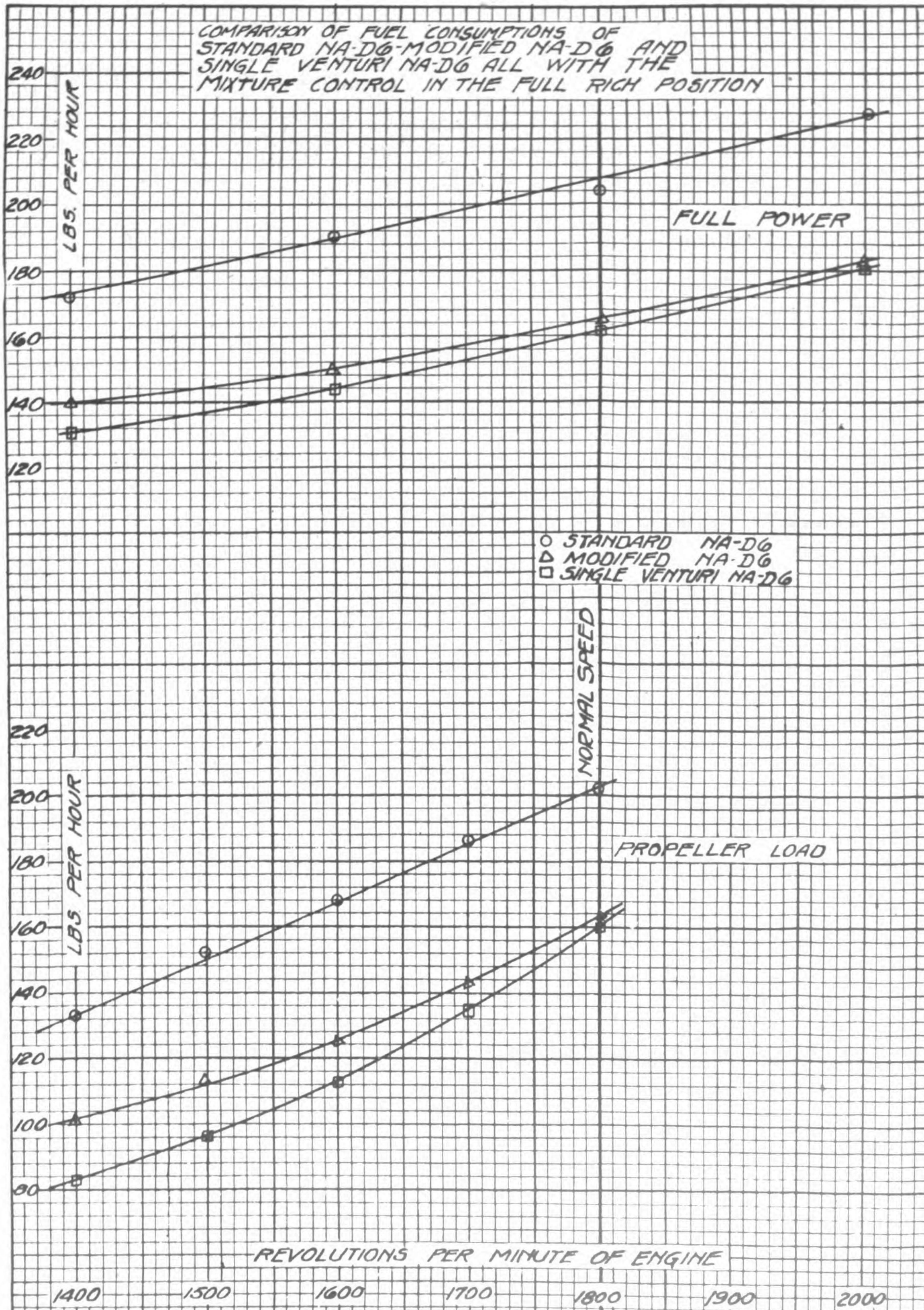

COMPARISON OF FUEL CONSUMPTIONS OF STANDARD NA-D6-MODIFIED NA-D6 AND SINGLE VENTURI NA-D6 ALL WITH THE MIXTURE CONTROL IN THE FULL RICH POSITION
LBS. PER HOUR
240
220
200
180
160
140
120
FULL POWER
○ STANDARD NA-D6
△ MODIFIED NA-D6
□ SINGLE VENTURI NA-D6
NORMAL SPEED
LBS. PER HOUR
220
200
180
160
140
120
100
80
PROPELLER LOAD
REVOLUTIONS PER MINUTE OF ENGINE
1400
1500
1600
1700
1800
1900
2000

FIG. 1.

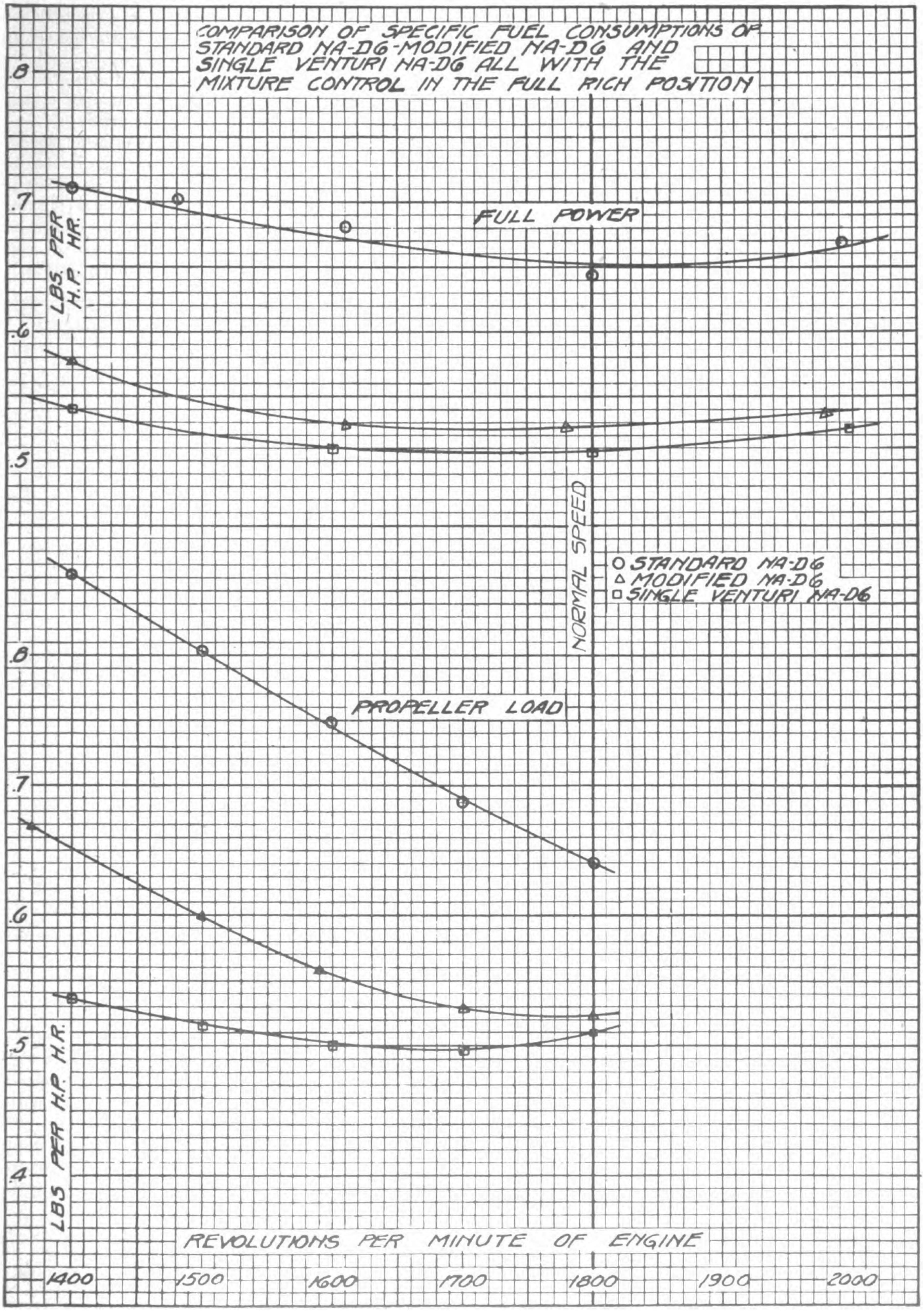

COMPARISON OF SPECIFIC FUEL CONSUMPTIONS OF STANDARD NA-D6-MODIFIED NA-D6 AND SINGLE VENTURI NA-D6 ALL WITH THE MIXTURE CONTROL IN THE FULL RICH POSITION
FULL POWER
LBS. PER H.P. HR.
NORMAL SPEED
O STANDARD NA-D6
△ MODIFIED NA-D6
□ SINGLE VENTURI NA-D6
PROPELLER LOAD
LBS PER H.P. H.R.
REVOLUTIONS PER MINUTE OF ENGINE
.8
.7
.6
.5
.8
.7
.6
.5
.4
1400
1500
1600
1700
1800
1900
2000

FIG. 2.

From the results of the first phase it was evident that it was impractical to prevent the enrichment of the mixture on propeller load by changing the air-bleed holes in the accelerating well. It was also evident that one reason why the engine required such a very rich mixture for acceleration was because upon a sudden opening of the throttle the fuel lying around the accelerating well had a great distance to travel before discharging into the main air passage. It was, therefore, decided to reduce the fuel consumption on propeller load by eliminating the auxiliary or small venturi. It was believed that if the accelerating well was raised close to the discharge nozzle, the acceleration with the single venturi would be satisfactory. An arrangement of this kind was constructed (see fig. 6) and the usual runs made. The fuel consumption (see fig. 2) and the acceleration when the carburetor was in a level position were excellent. However, due to the distance from the center of the float to the accelerating well, when the carburetor was tilted, as it would be in flight, the fuel either spilled over the discharge nozzle or the level was below the accelerating well so that the engine would not accelerate. As it was impossible to change the relation of the discharge nozzle to the float chamber, the single venturi type of setting had to be abandoned, since it would not operate in inclined positions.

Since the fuel compensating characteristics could not be improved, it was obvious that the only method left to improve the fuel consumption with the carburetor in its present form was to devise an accelerating well which would improve the accelerating qualities to such an extent that the metering orifice size could be reduced and thus reduce the fuel consumption. After several trials a well of this kind was obtained, a sketch of which is shown in figure 7, and the fuel consumption curve given in figure 2. This well gives good acceleration in all normal flying and ground positions with a No. 35 metering orifice, which materially reduces the fuel consumption.

Fuel consumption curves for the various arrangements tested both for propeller load and full-throttle runs will be found in figure 1 and specific consumption curves in figure 2. These consumptions were all taken with mixture control in the full rich position, and a careful pilot using the mixture control would materially reduce the consumption shown by the curve for the standard setting.

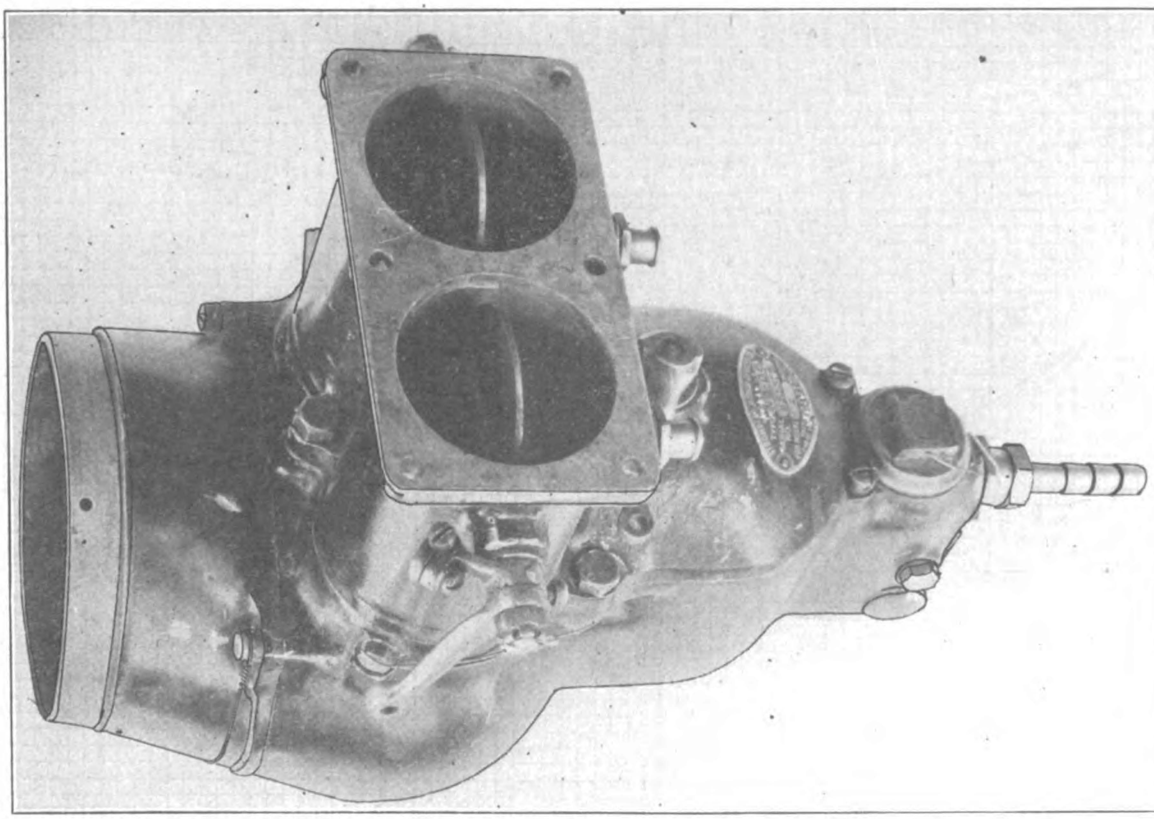
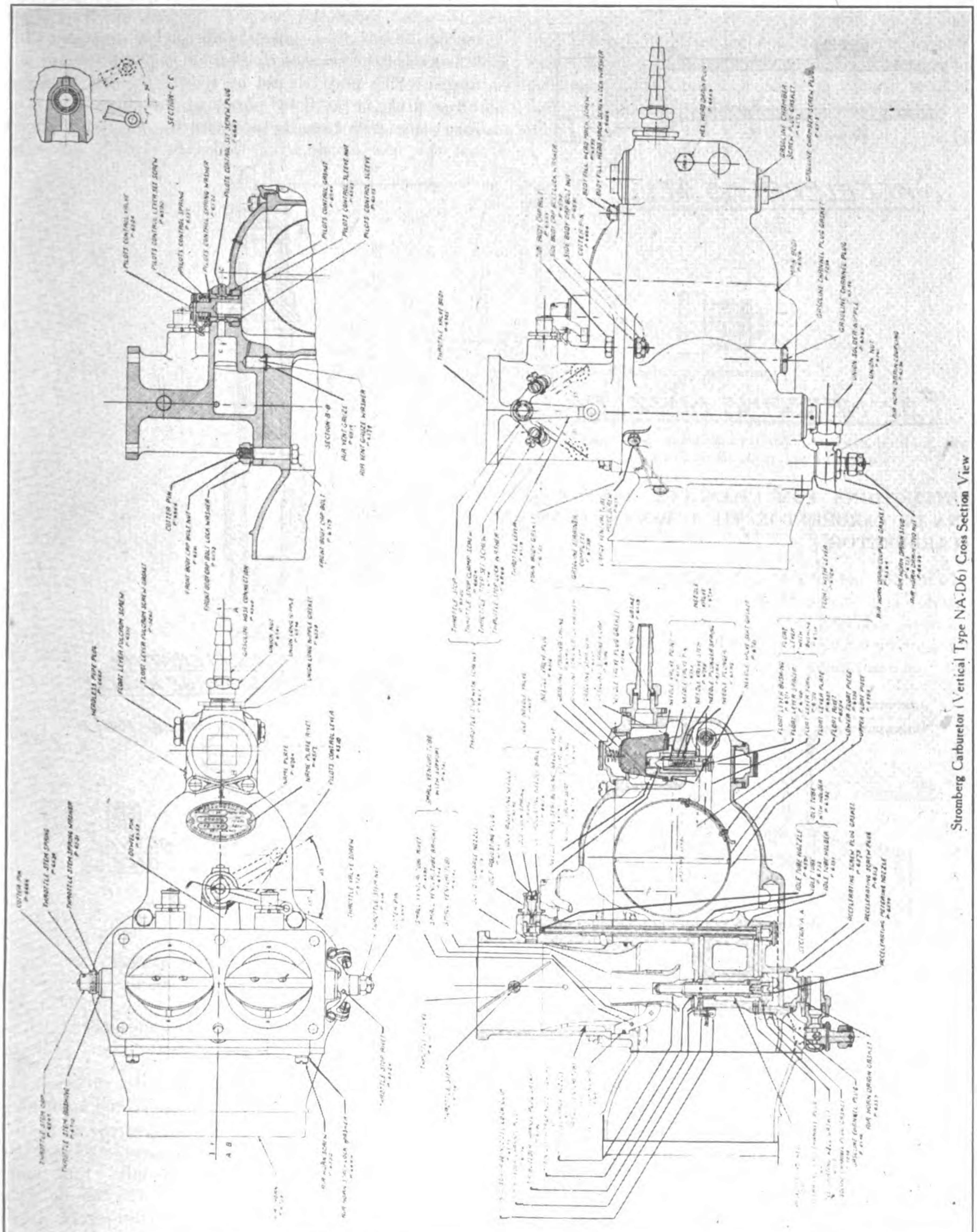


FIG. 3.—View of Stromberg NA-D6 carburetor.

ANALYSIS.

Up to a certain limit, determined by the acceleration, the fuel compensating characteristics of an air-bleed accelerating well can be changed at will by a change in the number, size, or location of the air-bleed holes. With a single venturi, a practically ideal fuel consumption curve can be obtained over the propeller load range by proper sizing of the air-bleed holes. Raising the accelerating well with relation to the discharge nozzle improves the acceleration.

In general, it is evident that the NA-D6 carburetor has some inherent disadvantages such as distance from discharge nozzle to center of float, which can be eliminated only by complete redesign of the carburetor. It is believed that the changes developed by this test allow of



Stromberg Carburetor (Vertical Type NA-D6) Cross Section View

FIG. 4.—Assembly drawing of Stromberg NA-D6 carburetor.

as lean a main-jet setting as is practicable for year-round operation, and as good compensation on propeller load as it is possible to obtain with the present NA-D6 carburetor body.

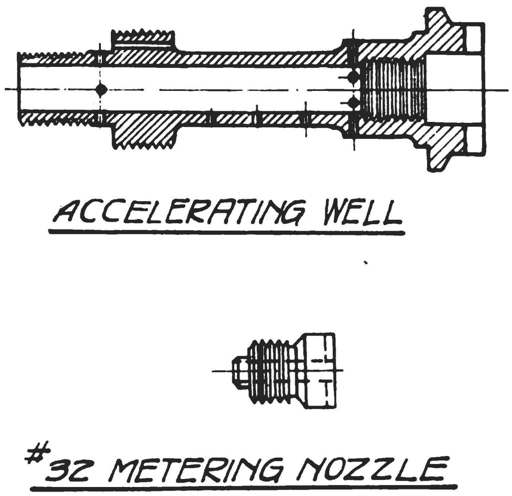


FIG. 5.—Sectional view of old type accelerating well and metering nozzle for NA-D6 Stromberg carburetor.

INSTRUCTIONS FOR CHANGING A STANDARD NA-D6 CARBURETOR TO A MODIFIED NA-D6 CARBURETOR.

To modify one NA-D6 carburetor, the following special material is required: 2 new type accelerating wells, 2 new type discharge nozzles, 2 No. 35 metering orifices, and 2 air metering plugs (see fig. 7). After securing the new type equipment, separate the halves of the carburetor

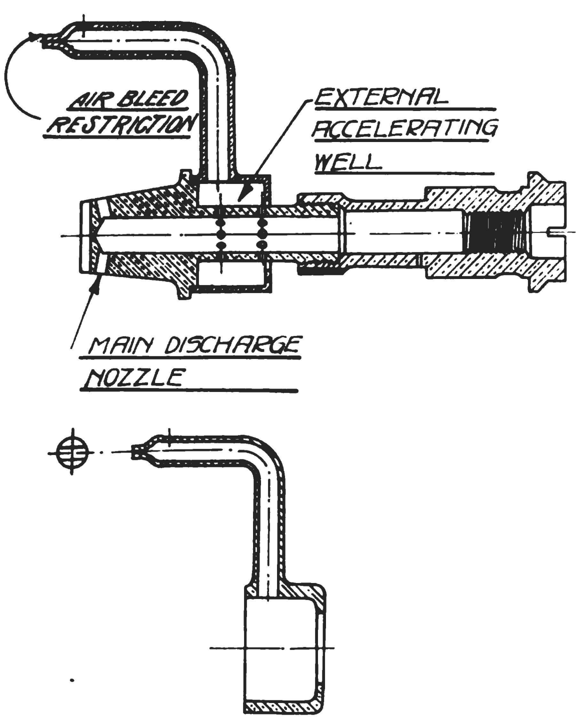


FIG. 6.—Accelerating well and discharge nozzle used with single venturi in NA-D6 Stromberg carburetor.

and remove the venturis and accelerating wells and proceed as follows:

Two air vent holes will be found in the carburetor as at (A) (see fig. 8). Drill and tap these holes for $\frac{1}{4}$ inch—32 threads. Screw the two small brass air metering plugs (see fig. 7) into these holes. Care should be taken that the edges of the air metering orifice in the plugs are not injured. The plugs should be tightly screwed in place and securely fastened by punching the edges in two or three places with a small center punch. It will be noticed that the new accelerating wells are slightly larger in

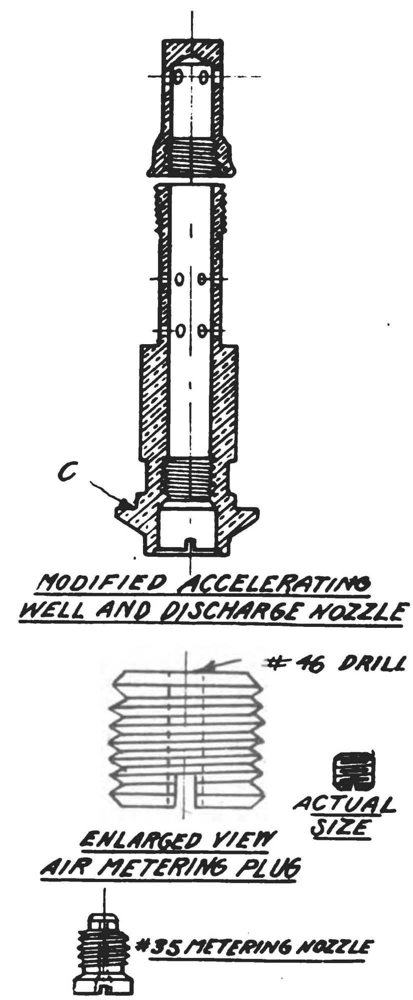


FIG. 7. New type equipment for Stromberg type NA-D6 carburetor.

diameter than those removed. It will, therefore, be necessary to slightly enlarge the holes in the main body of the carburetor at (B). For this purpose a $\frac{7}{16}$-inch drill will be necessary. It is necessary to enlarge the first thin section of material at (B) only. First make sure that the shoulders on the bottom (B) (see fig. 7) of the accelerating wells have a fiber gasket in place. Insert the new accelerating wells in their position in the carburetor and fasten securely by screwing the new type discharge nozzles on the top of the accelerating wells. Securely screw the discharge nozzles in place. These

should be fastened with the old discharge nozzle lock clip. Screw the No. 35 metering jets in their place in the bottom of the accelerating wells, reassemble carburetor and safety wire for service use. Mark the aluminum name plate with the letters MOD ½ inch high immediately above the letters TYPE NA-D6. The letters should be stamped with steel stamps. It is of the greatest importance that all modified carburetors have this distinctive marking as there is great possibility of confusion since the type of setting can not be determined by external examination. It is recommended that in addition to this marking the bowls or other prominent part of the carburetors be painted with the letters MOD one to two inches high with yellow paint.

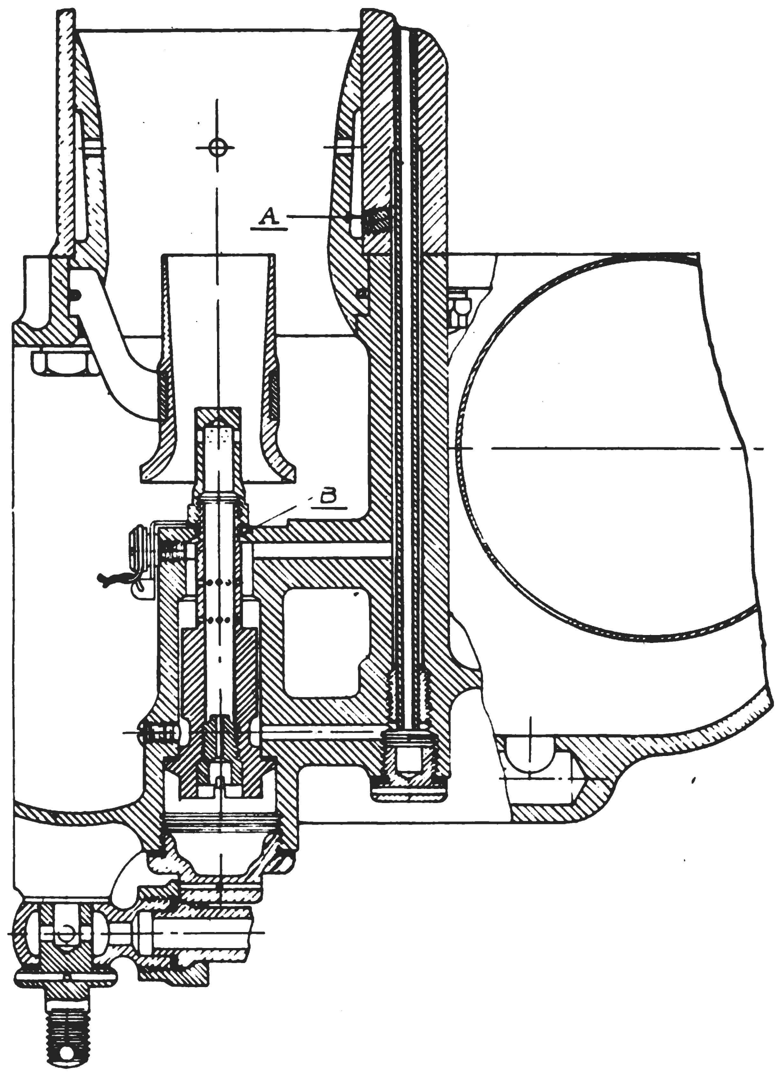


FIG. 8.—Sectional view of modified NA-D6 carburetor showing new wells, jets, discharge nozzles, and air-metering plugs in place.

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